Annual Report to OGP
GAPP supported project
"Assessing and accounting for Model Related Errors in Climate Forecasting"

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Tasks completed in Year 1 (see appendix for reference to the planned tasks):
1).Planned Year 1 task 1), partially completed.
   A basic version of an ensemble based model diagnostics tool, outlier-statistics, was developed and used to diagnose model related errors. The method will need to be refined and a paper to be prepared in Year 2.
2).Planned Year 1 task 2), completed.
   A Data set for the period of August and September, 2002 was wet up for running different ensembles with different cumulus parameterization schemes (CPS) .
3).Planned Year 1 task 3), completed. *
   Three model versions of the NCEP Global Forecast System were tested, one with the Simplified Arakawa-Schubert (SAS) scheme as its CPS, another with Relaxed Arakawa-Schubert (RAS) scheme, and the third without a CPS scheme (NAS).
4).Planned Year 1 task 4), completed.
   Generation of 3 sets of ensemble forecasts with the 3 model versions, for the period of August, 2002.
5).Planned Year 2 task 1), completed.
   Generation of 3 sets of ensemble forecasts with the 3 model versions, for the period of September, 2002.
6).Planned Year 2 task 3), partially completed and in progress.
   The ensemble forecasts from the three model versions, and a few similarly sized combined ensembles are analyzed and the results show that systematic variation in the model forecast using the three model versions is not significant and combination of SAS and RAS ensemble did not provide significant improvement in the ensemble forecast.

   * Reflecting to the reduced level of funding and logistic problems, the Emanuel CPS scheme was excluded from the experiment after consultation with Kerry Emanuel and Hua-Lu Pan, and approval by OGP. NAS was included to minimize the negative effect of this change, and the experiment lead to meaningful conclusions and provided practical guidance for further research.

Revised Work Plan Plan for Year 2 and Year 3
   As the result of the analysis of the ensemble forecasts carried out in Year 1   (task 6) suggests that the variation in model CPS schemes is unlikely to produce significant systematic variation in model forecast, it is decided that the research during Year 2 and Year 3 should be concentrated on stochastic physics with various formulations and the plan is revised according to this decision.

Year 2:

1) Continue and finish the Comparative evaluation of ensembles with various CPSs, and some similarly sized combined ensembles, using probabilistic verification tools including outlier statistics.
2) Statistically bias correct ensembles from the three model version and some more similarly sized combined ensembles and perform analysis similar to task 1).
3) Investigate into the structure of difference fields between the high resolution single forecast and a relatively low resolution run.
4) Carry out preliminary experiments to study the effects of horizontal diffusion on the characteristics of GFS ensemble forecasts.
5) Modifying code and scripts and setup data sets for experimental period (during Spring-Summer, 2004).
6) Development and test of a number of ensemble based model diagnostic tools for the analysis of different ensemble forests, and prepare a paper on the outlier statistics.

Year 3:
1) Generating ensemble forecasts with various stochastic physics formulation schemes.
2) Comparatively evaluate ensembles with various stochastic physics formulation schemes, using the ensemble based model diagnostic tools developed in Year 1 and Year 2.
3) Select the stochastic physics formulation schemes best suited for representing model related uncertainty.
4) Design and implement procedure to incorporate the selected scheme .
5) Compare performance of experimental ensemble to the operational ensemble forecasts.

Presentations:
Hou, Dingchen, Zoltan Toth, Yuejian Zhu and Richard Wobus: Preliminary results of ensemble forecast with multiple versions of NCEP's GFS model. GEWEX Americas Prediction Projects (GAPP) 2003 PIs Meeting, Seattle, WA, July 16-18th, 2003.

Hou, Dingchen, Zoltan Toth, Yuejian Zhu and Richard Wobus: Performance of ensemble forecasts with multiple versions of NCEP's GFS model. *The 16th Conference on Numerical Weather Prediction,* Seattle, WA, Jan. 11-15th, 2004**.**

Hou, Dingchen, Zoltan Toth, Yuejian Zhu and Richard Wobus: An analysis of the use of different physical parameterization schemes in an ensemble forecast system. *European Geosciences Union 1st General Assembly,* Nice, France, 25-30 April, 2004.

Appendix: Originally planned work for the project

YEAR 1:

1) Develop and test ensemble based model diagnostics tool
2) Set up data for experimental periods for running different ensembles
3) Test two model versions with various Convective parametrization schemes (CPS)
4) Start generating ensemble forecasts with various CPSs

YEAR 2:

1) Continue and finish the generation of ensembles with various CPSs
2) Staistically bias correct ensembles with various CPSs
3) Comparatively evaluate ensembles with various CPSs, and a similarly sized combined ensemble, using probabilistic verification tools including outlier statistics
4) Select CPS best suited for inclusion of changes for representing state dependent model related uncertainty

YEAR 3:

1) Design and implement procedure to incorporate parametric and structural uncertainty estimates in selected CPS
2) Compare performance of experimental ensemble to that using the original CPS schemes separately and combined
3) If successful, implement best experimental ensemble scheme into operational weather and/or climate forecast procedures at NCEP